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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Method and Apparatus for Dewatering Paper Machinewet Felts

We, HUYCK CORPORATION, a corporation organised under the laws of the State of New York, United States of America, of Washington Street, Rensselaer, State of New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to an improved method and apparatus for dewatering the felts used in a paper machine, and it is particularly concerned with the reduction of the water content of such felts in the wet stages of the production of paper.

In forming a continuous web of paper from a pulp slurry, it is usually considered necessary to apply a relatively thick layer of the pulp slurry to a felt while the slurry still has a quite high water content. It may, for example, have a water content of 80-90%, based on the wet weight of the total mixture, at the time it is applied to the first felt in a series of felts normally used in a complete papermaking machine, in the region that is in advance of the point at which the pulp attains the status of a self-sustaining sheet or web. As will be appreciated, the water content of the wet web of pulp or paper must be transferred to the felt, in the early press sections of the machine, in order to bring the consistency of the pulp mixture to the desired point, from the standpoint of its water content, at which it may be advanced through the final drying stages to make the finished web of paper. As a result of the transfer of the water to felt, particularly in the first press section of the machine, the felt reaches a relatively high water content in the course of its travel with the paper web, and it is then necessary to remove a substantial part of the water from the felt before the latter is again brought into position to receive another portion of the water content of the pulp slurry which is delivered to it.

Various schemes have been suggested heretofore for the purpose of removing water from the felt in the course of its advance through a region extending from the point where it leaves the paper web to the point at which it is again brought into the position where it receives another portion of the wet slurry. Such means have included press rollers between which the felt, in the region mentioned, has beeen subjected to a squeezing action to force out a certain part of its water content. In some instances the press used for the purpose has beeen provided with suction means intended to speed up the removal of water from the felt, and also prevent the objectionable accumulation of water in advance of the nip of the press rollers which has been found to slow down the permissible speed of operation of the machine and to produce objectionable effects upon the web of paper being formed. However, the various expedients of this character which have heretofore been employed have all been subject to certain objections. They have not made possible any substantial increase in the overall speed of operation of the machine because they have failed to provide the necessary void volume in the felt, at it is brought back into contact with another portion of the web, to enable the felt to accept the necessary amount of water from the web for the long sought high speed movement of the latter.

The various methods and means suggested heretofore have all led to certain difficulties which have imposed a definite limitation upon the speed of operation of the machine. One such difficulty has been the accumulation of excess water at the ingoing side of

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the nip and this has resulted in diluting of the sheet and "crushing". This occurs at relatively slow speeds of operation of the machine, whether the press is a plain press or is provided with a suction roll. The felt and web at the mid-point of a suction press are so compressed that the voids in the felt are substantially completely filled, and even excess water may be carried into the nip to force the press rolls somewhat further apart. The degree of compression in most of the nip region is such as greatly to reduce the porosity of the felt and inhibit the passage of air therethrough under the influence of the suction applied. Attempts have been made to overcome these difficulties by the employment of a blind drilled bottom roll in the press or by the provision of a second band, which has sometimes been formed by weaving of metal wire, running inside the felt. However, none of these schemes have made possible any substantial increase in the speed of operation of the machine without damage to the paper web. Thus prior efforts to remove water rapidly from the paper and the felt have all resulted in objectionable marking of the paper web due to high press roll loadings and the impossibility of preventing more than complete saturation of the felt as it is passed, together with the paper web, through the regular press rollers of the paper machine, with resulting disturbance of the matted relation of the pulp fibers forming the paper due to dislocations arising from the rapidity with which water is caused to issue from the web, both vertically and laterally, on the upstream side of the lower press roller of the machine. Plain presses which have been used up to the present time for squeezing water from the wet paper web or sheet into the supporting felt have been found limited to a surface speed of movement of 800-1000 feet per minute in order to avoid difficulties of the character mentioned. A higher speed of movement of the paper web has been attained through the provision of a suction action at the press, but this has also been unduly limited and it has still left the objectionable effect upon the formation of the desired paper sheet or web when the speed of operation of the machine has been increased to a desired point. One difficulty that has been noted in connection with the provision of the suction means is that a very substantial percentage of the water drawn into the perforations of the roller to which suction is applied will remain in those openings as they pass beyond the suction box and this water will then be thrown by centrifugal force outwardly from the roller back to the felt.

A primary purpose of the present invention has been to provide an arrangement by which the felt, as it is brought into the region where it receives the paper web from a Fourdrinier wire or the like, has a much lower water content than has heretofore been permitted to remain. This makes possible the transfer of a higher percentage of water from the paper web into the felt before the latter becomes saturated to the point where water will flow backwardly around the lower press roller on the upstream side. The present invention has been found to make it possible to operate the machine at a much higher overall speed without running into the difficulties heretofore encountered through the development of an excess quantity of water in the region of the nip of the press rolls.

To bring about the removal of a substantial percentage of the water picked up by the felt as it is squeezed, along with the paper web, in passing through the regular press of the machine, the felt after being separated from the paper web on the downstream side of the press is passed through one or more regions in which the water content of the felt is expeditiously and greatly lowered without harmful effects upon the felt structure.

In accordance with the invention, there is provided a method of drying a paper machine felt in the course of operation of the machine during its travel between a point at which the felt leaves a pair of press rolls and is separated from a wet web and a point at which the felt is again brought into contact with another portion of the wet web, which comprises blowing air under a substantial superatmospheric pressure through successive portions of the felt to force the water therefrom for a sufficient period of time and at a sufficient pressure to reduce the water content thereof to between 10 and 40%, wet basis.

With the invention the air under pressure forcibly acts upon the water within the cavities of the felt structure and upon the water coating the fibers and yarns and urges this water outwardly into a suitable receptacle or enclosure from which the water may be continuously withdrawn. In one form of the invention the felt is simply advanced continuously through one or more regions in which it is held by a sealing action against a device having a slot or series of slots or perforations through which air under superatmospheric pressure may be blown through the felt. The opposite side of the slot, or series of slots or perforations, communicates with a receptacle which may be either at atmospheric pressure or at a sub-atmospheric pressure, the water and air mixture being continually discharged from the receptacle. To produce the maximum purging action of the air so blown through the felt, it has been found highly desirable to have the air at substantially room temperature and not at an elevated temperature.

The higher density of the air at the lower temperature will provide a more effective water purging action.

The invention will now be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view showing one arrangement for purging water from a felt by air under superatmospheric pressure; means provided for this purpose is shown in relation to conventional press rolls of a papermaking machine;

Fig. 2 is a perspective view showing schematically a modified arrangement for applying air under pressure to a web felt for dewatering the latter;

Fig. 2A is a schematic view showing, in elevation, the relationship of various parts involved in the arrangement of Fig. 2;

Figs. 3, 4, 5, 6, 7, 8, 9 and 10 are perspective views showing details of various arrangements for providing an effective seal against loss of the water purging air;

Fig. 11 is an elevational view, partly in vertical section, showing a still further form of apparatus which may be employed in carrying out the invention;

Fig. 12 is a perspective view illustrating a sealing arrangement which may be incorporated in the construction of Fig. 11;

Fig. 13 is a schematic view of yet another form of apparatus which may be employed to effect water purging of felts by air under pressure;

Fig. 14 is a detail view showing in cross-section one of the cylinders employed in the Fig. 13 embodiment of the invention; and

Fig. 15 is an elevational view, partly in vertical section, showing still another embodiment of the invention.

The purging of the water from the felt by the passage of air under superatmospheric pressure therethrough may be effected while the felt is simultaneously subjected to compression to a substantial extent in the region in which the air is blown through it. For example, the felt may be passed through the nip of two perforated or slotted rollers which are rotated to impart a peripheral speed thereto commensurate with the desired speed of operation of the papermaking machine. Within the upper roller there is provided a box which has a sealed relation to the inner wall of the roller, and which is completely enclosed except over the arcuate portion that communicates with the slots or perforations in the roller. Air under a desired pressure is constantly fed into this box, is then forced through the slots or perforations, then through the felt in the nip region of the rollers. The water thus purged from the felt is discharged into a similarly arranged box within the lower, slotted or perforated roller. To avoid wastage of air and obtain the maximum benefits of the invention most efficiently, it has been found desirable to confine the arcuate, open face of the box in the upper roller to the upstream side of the latter, i.e. from the area in which the felt is first compressed to the line of maximum compression by the rollers, i.e. that region in which the felt is subjected to increasing compression. The arcuate extent of this nip region will vary with the thickness of the felt being used, so that in any standard equipment of fixed construction the arc through which the air is delivered to the felt should be limited to that in which a felt of minimum thickness will be subjected to increasing compression for the most economical use of air. On the downstream side of the point of maximum compression of the felt the air will flow more freely, because of the previous removal of water from the interstices of the felt. While this air will entrain and remove further moisture, it will economize on air consumption if the box in the upper roller terminates adjacent the line of a maximum compression of the felt, and does not extend a substantial distance downstream from this line. Also, to purge water with a minimum consumption of air from felts of different types and thicknesses that may be applied to a particular paper machine, it may be found desirable to construct one or both of the air delivering and water receiving boxes within the squeeze rollers to enable adjustment thereof to extend over different arcs. However, this is not essential and the air delivery box and the air and water receiving box may be of fixed dimensions and extend over equal arcs at opposite sides of the nip. The water receiving box may advantageously be connected to a pump capable of producing a sub-atmospheric pressure to induce a higher pressure differential across the felt and thus a superior entrainment of water.

By an arrangement of the character described, a felt having a water content of say 60 to 75%, wet basis, as it approaches the nip of the slotted or perforated squeeze rollers, will be gradually compressed until the water content reaches substantial saturation, i.e. the condition in which all of the interstices within the felt are filled with water. By per cent water content of moisture "wet basis" is meant the weight of the water in a specimen divided by the total weight of the wet specimen times 100, as determined by the procedure described in ASTM Standards for Textile Materials, Tentative methods for Quantitative Analysis of Textiles, ASTM designation D629-59T, pages 317-8, 31st Ed., published Nov. 1960. At the time indicated the air under pressure works most effectively to force the water out of the interstices. Moreover, as the felt advances toward the line of maxi-

mum compression, the squeezing action upon the felt serves to cause the remaining water to fill substantially all of the voids or interstices left within the squeezed felt. It will be understood that the rate of advance of the felt, the pressure of the air which produces the purging action and the diameters of the press or squeeze rolls may be so selected as to insure substantially 100% filling of the interstices of the felt as the latter is advanced throughout the region on the upstream side in which the felt is being subjected to increasing compression. This will make the purging action of the air efficient throughout the region specified. If the delivery of air is limited to the upstream side of the maximum compression line there will be no tendency of the air to blow freely through channels or passages in the felt that are not filled with water. However, as indicated above, the high velocity movement of air through the felt after the initial piston-like action of the air on the substantially saturated portions of the felt will further decrease the water content, if the air under pressure is delivered to the felt in a region downstream from the line of maximum compression of the felt.

Actually it is not necessary to compress the felt to the point that all of the interstices are filled with water. High speed and efficient purging will take place if, at the time air under pressure is blown through the felt, the water in the felt forms a continuous, imperforate film or layer, so that there is no free air passage through the felt. For this purpose the extent of saturation of the felt may be less than complete as it is subjected to the water purging action of air under pressure.

In the practice of the invention it is important to provide effective sealing means on all sides of the region in which the air is being blown through the felt, so that the escape of air under pressure in lateral directions, rather than through the felt, will be held to a minimum. This not only conserves the air being used but also prevents spattering of water in directions in which it may do harm.

Referring now to Fig. 1, this shows a web of paper 10 being delivered from any suitable part of a conventional papermaking machine, such as the Fourdrinier wire or the couch rolls of such a machine, to a felt 11. The latter may be of any conventional form and will be of the character found preferable for the removal of water from the paper web, depending upon the type of paper being produced. The web 10 and the felt 11 are advanced at a quite rapid rate in the direction indicated by the arrow and they are passed through the nip of presser rolls 12 and 13. These may be of the imperforate type adapted to impart simply a squeezing action to the paper web and felt as they pass through the nip. However, if desired, the lower presser roll 13 may be a perforated cylinder or one that is otherwise provided with suitable passages through the wall thereof, and there may then be provided in the region of the nip of the press a suction box within the roll 13 to assist in the removal of the water being squeezed out of the paper. Such suction means and the provision of perforations in the roll 13 are not required however if the felt is reduced to the state of dryness preferably provided in accordance with the invention, i.e. with a water content of between 10% and 40%, wet basis, since the water squeezed from the paper will then not completely saturate the felt even in its compressed state between the rollers 12 and 13.

After the paper web and felt have passed through the nip of the press rolls, the paper web may be picked up in the conventional manner and delivered to a subsequent portion of the papermaking machine, such as another stage of the drying section. The felt will be passed around suitable rollers 14 and 15 and then delivered to a first stage of the water purging means contemplated by the present invention. This means, as shown, may include a drum or cylinder 16 which is held stationary. It is provided at one end with an opening 16a for the introduction of air under a suitable pressure, and its periphery is provided with a slot 16b which extends substantially across the width of the felt. The latter is held upwardly against the drum 16 in the region of the slot 16b by means of cylinders or rods 17 and 18. These cylinders or rods are adapted to retain the felt firmly against the outer periphery of the drum 16 at each side of the slot 16b and thus provide an effective seal in the region of the passage 16b through which the air under pressure is being blown. Suitable sealing means may also be provided adjacent the side edges of the felt to eliminate any tendency of the air under pressure to escape in the lateral direction. Such edge sealing means may be of the same general character as the cylinders or bars 17 and 18. All of these sealing means may be formed of a material which is wear resistant and which at the same time will not wear out the surface of the felt as the latter is being passed at high speed through the purging region. Suitable materials for this purpose are synthetic plastics, such as polytetrafluoroethylene and Rulan (which is a polyethylene resin).

It will be noted that the surface of the felt which is supporting the paper web at the nip of the presser rolls 12 and 13 will be at the underside of the passage between drum 16 and cylinders 17 and 18. This is desirable, since any impurities or particles

picked up from the paper web at the press rolls will then be expelled downwardly into a suitable receptacle 19 as the air under pressure within the drum 16 forces the water with a piston-like action from the felt. The receptacle 19 is provided with an opening 20 in its bottom which may be connected with any suitable delivery system for disposing of the water and impurities purged from the felt.

After being subjected to the water purging action of the air under pressure in drum 16 the felt will be advanced around a pair of rollers or cylinders 21 and 22 and then through a second water purging arrangement similar to that described. This second arrangement may include a drum 23 having an inlet 23a for the introduction of air under pressure and a slot 23b for discharge of air under pressure through the felt as the latter is held firmly against the drum 23 by cylinders or rods 23c and 23d and by edge sealing members of the character described above. After passing beneath the drum 23, the felt is then passed around rollers 22a and 22b and brought back into engagement with another portion of the paper web. In its passage beneath the slot 23b, the felt will be in inverted relation to that in which it passed through the first purging means described. This tends to insure a more complete drying of the upper surface of the felt as the water within its passages or interstices is blown into a receptacle 24 from which it is led through an outlet 24a to any desired point of disposal.

The width of the slots 16b and 23b, in the direction of movement of the felt may be of any suitable dimension. These slots should be wide enough to insure an adequate time for the air under pressure to force a substantial amount of water out of the passage through the felt, by a piston-like action, as successive sections of the felt pass across the slots. In some instances it may be found desirable to have a number of purging units 16 arranged to operate upon the felt successively, and also a number of purging units 23 similarly arranged to operate successively on the felt in the second stage of the dewatering operation.

In some instances, where the speed at which the felt must be advanced is quite high, in order to keep up with a high speed operation of the paper machine, it may be found desirable to support the felt by a strong porous fabric or wire belt in the regions of the purging units 16 and 23. This will permit the provision of circumferentially wide openings 16b and 23b, which may suitably be subdivided by partitions into a number of sections and will also permit the use of air under relatively high pressures. Two such belts are indicated schematically at 25 and 26 in Fig. 1. They will assist in holding the felt firmly against the drums 16 and 23 in the regions of the slots 16b and 23b, and thus prevent bulging which might occur if the slots are of substantial width and the air pressure is high. Also they assist in maintaining the desired effective seal around the air delivering slots. As shown in Fig. 1, the belt 25 is supported by rollers 25a, 25b, 25c and 25d, one of which may be driven to cause the upper course of the belt to travel in the same direction and at the same speed as the cooperating portion of the felt. By applying an appropriate tension to the belt, and with the aid of the cylinders or rods 17 and 18, a certain squeezing action may be imparted to the felt in the region of the opening 16b. The belt 26 may be supported by rollers 22, 26a, 26b and 26c, and it may be driven and tensioned in the same manner as belt 25. In lieu of this arrangement the belt 26 may be caused to follow the felt 11 around the rollers 22a and 22b, then through the nip of the press rolls, around roller 14, and then to roller 26c, whose location may be shifted slightly to avoid contact of the downwardly extending portion of belt 26 with the lower portion of roll 13. This arrangement has the advantage of enabling water to be squeezed from the felt into the supporting belt as they pass through the nip of the press rolls. Then as the felt and the belt 26 pass beneath the drum 23 the water is purged from both the felt and belt.

In the use of the term "felt" herein, it should be understood as referring to belts formed of any of the materials conventionally employed in the production of felts or fabrics used for conveying the wet paper web through the press rolls of the paper machine.

To bring about the removal of a substantial amount of water from the felt by the air purging action, it has been found desirable to subject the felt to the action of the air for a substantial fraction of a second. This is in order to achieve an important purpose of the invention, namely the reduction of the water content of the felt to between 10% and 40%, wet basis, i.e. of its wet weight, before successive portions are again brought into engagement with the wet paper web. The following table indicates the results obtained in connection with a number of different types of felts within 0.5 second purging time, with certain felts subjected to 25% compression and other felts subjected to 30% compression and also with all of the felts subjected to 50% compression at the time of the purging action.

30% Compression				*0.5 Sec Purging Time*		
Design	*126*	*95*	*207*	*30*	*176*	*269*
Initial Moisture (%)	60.3	59.7	62.4	64.0	65.4	62.9
% Moisture loss	20.7	14.0	9.7*	11.6	11.3	11.9*
No. of samples tested	5	3	3	4	4	3

* 25% Compression

50% Compression				*0.5 Sec Purging Time*		
Initial Moisture (%)	59.3	58.6	61.4	64.8	65.4	62.2
% Moisture loss	23.4	18.6	16.4	13.6	15.5	21.2
No. of samples tested	4	3	3	3	3	2

In a similar manner, the following table shows the effect of a 0.25 second purging time during which air under pressure is forced through the felts with the latter compressed firstly to 25 or 30% compression and then to 50% compression.

30% Compression				*0.25 Sec Purging Time*		
Design	*126*	*95*	*207**	*30*	*176*	*269**
Initial Moisture (%)	60.1	59.0	62.4	63.7	64.6	62.9
% Moisture loss	16.8	13.0	8.8	11.0	10.1	11.4
No. of samples tested	4	3	5	3	4	2

* 25% Compression

50% Compression				*0.25 Sec Purging Time*		
Initial moisture (%)	59.0	58.6	61.5	65.0	65.5	61.7
% Moisture loss	21.3	16.7	16.2	12.0	14.0	19.9
No. of samples tested	4	4	3	1	4	5

Still another test applied to a felt designated 259, with air blown through it while the felt was under 50% compression for the fractions of a second indicated in the table below, shows that substantial amounts of water were removed within 0.17 second.

Felt compression	*50%*			
Purging Time Sec.	0.17	.33	.32	0.42
Initial Moisture (%)	61	61	62	93
After purging (%)	40	39	37	39
Removed (Abs. %)	21	22	25	24
Cfm Air at 30 psig.	127	277	309	336

The various felts involved in tests reported in the foregoing tables were of the following types:

C. F. Wet 126

Common Fourdrinier press felt; reverse broken twill weave, weighing 3.5 ounces per square foot. The design contains approximately 25% nylon, 75% wool; it is frequently used in making newsprint.

Common Wet 259, 269

Used on cylinder machines making a wide range of box board and cardboard; 4 harness satin weave. Felts weight approximately 2.8 ounces per square foot, 100% wool. The #269 is a lighter, thinner version of #259. It weighs about 2.2 ounces per square foot.

S. F. Press 176

A fine press felt, duplex, plain plus satin weave, 2.6 ounces per square foot. The filling yarns contain 25% nylon; warp is 100% wool. It is used on a wide variety of Fourdrinier first presses.

Plate 95

A very fine press felt, modified satin weave, 100% wool; approximately 3.0 ounces per square foot. It is used on a wide variety of second and third press positions making smooth finish papers.

Super Plate 30

Like #95 but thinner and capable of producing much smoother paper, 2.6 ounces per square foot, 100% wool.

Pulp 207

A coarse, plain weave felt, 25% nylon, 75% wool, weighing about 3 ounces per square foot. Used in making coarse grades of roofing paper and in extracting water from pulp sheets.

By preparing graphs from the data provided in the foregoing tables, it appears clear that a very substantial amount of water may be purged from a wet felt by forcing air under pressure through the felt during a smaller fraction of a second than specifically indicated in the tables. It appears that one-tenth of a second, or even somewhat less, is adequate time for the purging of a quite substantial amount of water from a wet felt, particularly when the felt is in a compressed condition at the time the air is blown through it. However, to achieve the extent of reduction of water content of the felt desired for the primary purpose of the present invention, it seems necessary

to subject the felt to the air purging action for at least 0.08 of a second if the felt is not being compressed substantially at the time the air is being blown through it. In general, it may be stated that a greater amount of time is required when the felt is not compressed at the time the air is blown through it. Some improvement in the extent of water removal by the air under pressure is produced by increasing the extent of compression of the felt, but the increase in the rate of water removal after the felt has been compressed to the extent of 50% of its normal thickness hardly warrants higher compression. Thus, compression to the extent of between 30 and 50% is considered to be best for the purposes of the invention.

The speed of removal of a desired percentage of water from a felt depends to a substantial extent upon the pressure maintained on the air that is blown through the felt. In the tests reported in the foregoing tables the air was withdrawn from a tank having an initial pressure of 30 lbs./sq. inch. At the end of 0.5 sec. purging the pressure dropped to 16.5 lbs., while at the end of the 0.25 sec. purging the pressure had dropped to between 21 and 22 lbs. Of course in the regular commercial use of the invention the air supply system will be such as to maintain a substantially uniform pressure of the desired amount. But other test data indicates that to achieve a substantial reduction in the moisture content of the felt within a brief time interval of less than 0.5 second it is desirable to employ air under a pressure of at least 8 psi above atmospheric. The preferred pressure is in the range between 10 and 40 psi above atmospheric, but higher pressures, up to 100 psi, may be used provided the felt is of such character and is so supported at the time the air is blown through it, that no harm will be done to the felt by the high pressure air.

Referring now to Figs. 2 and 2A, there is shown schematically another form of apparatus which may be used for the air purging of water from wet felts. The felt is indicated at 27 and it is passed around a roller 28, which may be the lower roller of one of the press roll units of a paper machine, corresponding with roller 13 of Fig. 1. From this point the felt is passed round a roller 29 which may suitably be supported for movement in the direction indicated by the arrows to apply the desired amount of tension to the felt. It then passes around rollers 30 and 31 back to the press roll 28. The felt may be advanced by a belt connection 32 from a pulley on the output shaft of a variable drive mechanism 33 to a pulley connected with roller 31. Drive mechanism 33 may include an electric motor and suitable reduction gearing. In their movement from roller 30 to roller 31 the successive portions of the felt pass beneath a hood 34 into which air under a desired pressure may be blown through a line 35 and an opening 36 in the hood into the interior of the latter. The bottom of the hood is provided with transversely extending partition members 37 to form a plurality of passages 38 for the discharge of the air under pressure through the felt. As will be explained in greater detail hereinafter, suitable provision is made for an effective seal between all sides of the lower edge of the hood and the surface of the felt to prevent any substantial escape of air laterally from the hood without passing through the felt.

Beneath the felt, in vertical alignment with the hood 34, is a receptacle 39 which is preferably arranged for vertical adjustment into and out of engagement with the undersurface of the felt. In moving the receptacle upwardly, it may be urged under a suitable pressure against the felt so as to exert a squeezing action upon the latter to compress the felt to a desired extent. Receptacle 39 may be provided with transversely extending partitions aligned with partitions 37 of the hood to make possible the squeezing and compressing action on the felt throughout a portion of the length of the hood. The lower ends of the partitions 37 and the upper ends of similar partitions in the receptacle 39 are preferably provided with a layer of a low friction producing and good wear resistant material, such as polytetrafluoroethylene or Rulan. In lieu of this partitioning of the receptacle it may, however, be provided with a plurality of rollers 40 adapted to retain and guide a belt 41 formed of fabric or wire, or the like. This belt, which may be similar to the belts 25 and 26 of Fig. 1, is additionally supported by rollers 42, 43, 45, 46, 47 and 48. It may be driven at the same speed as the felt by a suitable connection from the drive means 33 through a belt 49 connected with a pulley carried by the roller 45. The roller 46 is preferably arranged for movement in the direction of the arrows shown in Fig. 2A to apply a suitable tension to the belt 41 and to enable the upper course of the belt to be lifted and lowered in relation to the hood 34. Water and impurities purged from the felt and forced through the belt 41 into the receptacle 39 may be removed from the latter along with the air through an outlet 50.

An advantage of the foregoing construction schematically illustrated in Fig. 2A, with or without a supporting, abrasion-resistant belt 41, is that it makes possible the exposure of the felt to the air under pressure for a longer period of time than is reasonably possible in a single purging arrangement of

the type shown at 16 and 23 in Fig. 1. Also it enables a somewhat greater compression to be applied to the felt in the region of the hood 34 and receptacle 39, by virtue of the lifting force adapted to be applied to the receptacle 39 and the belt 41 to urge the latter or the transverse partitions in the receptacle, against the undersurface of the felt.

In some cases it may be found that the simultaneous purging of water from the felt and a supporting fabric will not remove the water from the supporting fabric as fully as desired, so as to enable this to assist in carrying away the water discharged from the felt in the specified purging step. To insure substantially complete removal of water from the supporting fabric it may be found desirable to subject this to a separate purging action. Thus, as shown in Fig. 2A, air-jet supplying means may be provided to remove the water from the supporting fabric itself more fully and thus improve the effectiveness of the air purging action on the felt in its next pass beneath the hood 34. Any suitable form of air-jet producing means may be provided across a portion of the supporting fabric 41 after it has passed, along with the felt, through the combined air purging region of hood 34. For example, there may be provided an elongated tubular member 50a extending across the width of the supporting fabric, this tubular member having an inlet 50b for the introduction of air under substantial pressure, and outlet means 50c adapted to discharge jets of air through the supporting fabric. This outlet means may be in the form of a single narrow slot or in the form of a number of closely spaced passages of relatively small cross sectional area. The air discharged through the outlet means 50c removes a substantial part of the water remaining in the supporting fabric and delivers this into a receptacle 50d from which it may be discharged, along with the air, through an outlet 50e to any suitable point for disposal.

Since the purging effected by the air-jets discharged from member 50a is achieved by the high velocity movement of the air through the fabric, it is unnecessary to provide sealing means in this region. There is little or no tendency of the air to be deflected laterally along the surface of the supporting fabric.

It will be understood that a variety of other forms of high velocity, air-jet producing devices may be used, in lieu of the form schematically shown in Fig. 2A. Also it will be understood that similar means for separately removing water by means of air-jets from a supporting fabric may be employed in connection with other embodiments of this invention involving the use of a supporting fabric for the felt in the region in which it is subjected to the air purging action, such as that described in connection with Fig. 1 and that to be described in connection with Fig. 11.

Means of removing water from the supporting fabric, other than the air-jets mentioned above, may be employed effectively. These include the application of suction by suction boxes; the use of wipers or wiper blades; the use of scraper blades or deflectors that rest against the surface of the moving porous supporting fabric disposed at an acute angle to the direction of travel so that water is withdrawn and deflected from the pores, as commonly practiced on the moving wire forming screens of paper machines; blasting with steam; throwing free from the pores by centrifugal force; transfer from the pores to the surface of a rotating roll or drum with which the porous fabric runs in contact, and removal from such surface by scraping or wiping blades.

Referring now to Figs. 2-10 inclusive, there are disclosed schematically various arrangements for providing an effective seal along all of the edges of the hood 34. For example, as shown in Figs. 2 and 3, the seal along the longitudinal edges of the hood may be provided by a pair of continuously moving bands 51 and 52. These bands may be of circular cross-section, as shown in Fig. 3, but they may be of other cross-sections, as shown in certain of the other figures. The band 51 which effects the seal along the forward longitudinal edge of the hood 34, as seen in Fig. 2, may be trained around a series of pulleys 51a, 51b, 51c and 51d. This band may be advanced through its frictional engagement with the felt 27 or the supporting fabric 41, or it may be independently driven at the same speed of advance as the supporting fabric and the felt by suitable connections from the drive means 33. The run of this band advancing between the pulleys 51c and 51d will press against the edge portion of the supporting fabric or of the felt under a sufficient force to effect a good seal. Belt 52 is similarly trained around a series of pulleys 52a, 52b, 52c, 52d, 52e and 52f, which are positioned below the portion of the felt and the supporting fabric that is traveling toward the left (Fig. 2) beneath the hood. Pulleys 52b, 52c and 52d may suitably be carried or formed at the ends of the rollers 40 of Fig. 2A, or they may be journaled upon trunnions extending from the ends of non-rotatable members formed of bar stock, pipe stock or rods secured to the upper portions of the side walls of receptacle 39 in the positions shown for rollers 40 in Fig. 2A. In the latter even, these non-rotatable members should be formed of, or should be provided with a thick layer or coating in the regions which engage the belt 41 that is wear resistant and presents a low frictional resistance to the movement of the belt 41 there-

across. The belt 52 is urged upwardly against the edge portion of the supporting fabric with a suitable force to provide an effective seal. It may either be driven through its frictional engagement with the supporting fabric, or it may be independently driven by a suitable connection from the drive 33 to one or another of the supporting pulleys. At the opposite, or rear side of the hood 34, similar sealing belts may be provided to cooperate with the adjacent edge portion of the belt or the supporting fabric. This is indicated in part in Fig. 2 by the showing of the belt 51' which is supported and guided by pulleys 51'a, 51'b, 51'c and another pulley (not shown) aligned with the pulley 51d. It will be understood that a belt corresponding to belt 52 will be provided for cooperation with the belt 51' at the rear side of the hood, so that the longitudinal edge of the supporting fabric is gripped between the two belts.

For providing an effective seal along the right end of the hood 34 (Fig. 2) a stationary bar 53 (Fig. 3), which may suitably be rectangular in cross-section, is mounted in a channel member 54. The arrangement is such that the bar 53 is held in engagement with the upper surface of the felt 27 completely along the right end of the hood from a point adjacent the path of travel of the belt 51 to a point adjacent the path of travel of the belt 51'. Bar 53 is preferably formed of a wear resistant and low friction creating material such as Teflon or Rulan. A similar bar arranged in a similar manner across the left end of the hood serves to effect a good seal at that end, between the lower edge of the hood and the upper surface of the felt. Thus it will be seen that the entire area through which air is blown from the hood 34 through the felt and the supporting fabric will be sealed along its four edges to prevent lateral escape of the air. As shown in Figs. 4 and 5, the transversely extending bar may have a trapezoidal cross-section, as shown at 53' and the retaining channel member may have a similar cross-section, as shown at 54.

In lieu of the travelling belts 51 and 52, there may be provided stationary sealing means along the forward and rearward, longitudinal edges of the bottom of the hood. Thus, as shown in Fig. 6, there may be provided two angle members 55 and 56 which extend throughout the length of the hood. One or another of these members may suitably be arranged for vertical adjustment to facilitate the introduction of the felt and its supporting fabric between them. Member 55 has a downward projection 55a, preferably of semi-circular cross-section, adapted to urge the edge portion of the supporting fabric 41 into a depression 56a in the angle member 56. The engagement of the edge portion of the supporting fabric by projection 55a will be such as to urge it lightly into the depression 56a without causing any substantial resistance to movement of the supporting fabric, but at the same time to provide a quite effective seal against the lateral escape of air. Angle members 55 and 56 are preferably formed of or coated with a good wear resistant and low friction producing material, such as Teflon, Rulan, or the like. It will be understood that a similar arrangmenet can then be provided along the rearward longitudinal edge of the hood.

Fig. 7 discloses a further embodiment of suitable means for effecting a good seal along the longitudinal edges of the hood. It is similar to the arrangement shown in Fig. 3 but provides a longitudinally extending member 57 above the course of the felt which passes beneath the hood. This member 57 is so constructed as to provide a guide groove 57a of semi-circular form through which the lower course of the belt 51 may freely travel. This serves to insure firm engagement of the lower course of belt 51 with the upper surface of the felt or, if desired, merely the upper surface of the supporting fabric 41. A similar guide member may be provided below the supporting fabric 41 to insure proper retention of the horizontal course of the belt 52 against the undersurface of the edge portion of the supporting fabric. Fig. 8 discloses an arrangement similar to that shown in Fig. 7 but involves a channel member 57' arranged to receive and guide the upper course of a sealing belt 51" of rectangular cross-section. The lower belt 52", arranged in the manner of belt 52 in Fig. 2, is also of rectangular cross-section, and the two belts will then preferably cooperate with only the edge portion of the supporting fabric 41. Belt 52", at its forward end, passes around a pulley 52"a, and it will be understood that belt 51" passes around a similar pulley located in the position indicated for pulley 51c of Fig. 2. If desired, another channel member similar to member 57', but in inverted relation, may be provided for retention of the lower belt 52" against the lower surface of the supporting fabric throughout the length of the hood. In connection with the Fig. 7 and Fig. 8 arrangements it will be understood that corresponding belts will be provided along the rearward edge of the hood.

Still another form of sealing means is disclosed in Fig. 9. This comprises channel member 58 extending longitudinally of the hood adjacent its forward side and arranged to receive a sealing bar 59 of rectangular cross-section. Similarly, an angle member 60 disposed along the forward edge of the hood 34 is adapted to retain a lower sealing bar 61. Bar 59 is urged downwardly into engagement with the upper surface of the edge portion of the supporting fabric 41

by a number of springs 62 disposed within the channel of member 58. In the same manner, the bar 61 is urged upwardly under a suitable force into engagement with the lower surface of the supporting fabric by a series of springs 63 disposed in the channel of member 60. It will be understood that the bars 59 and 61 are formed of a good wear resistant and low friction producing material.

A further embodiment of the invention is schematically disclosed in Fig. 10. In this form, the felt 27 may have the supporting fabric 41 beneath the felt in the region in which it is being subjected to the purging action, and it may also have a similar fabric 41a applied to its upper surface of this portion of its run. Any suitable arrangement of pulleys may be provided for carrying and directing the upper fabric 41a, and connections from the drive unit 33 may be provided for advancing it at the same speed as the felt. Sealing along the longitudinal edges of the hood 34 may be effected by the provision of angle members 64 and 65 disposed respectively above the upper surface of fabric 41a and below the undersurface of the fabric 41. These angle members extend throughout the length of the air discharge opening in the hood and are preferably formed of wear resistant and low friction producing materials. The angle members at each side of the advancing supporting fabrics and felt are preferably so mounted in relation to the hood as to be shiftable vertically in relation to each other, so as to facilitate their assembly in proper relation to the felt and supporting fabrics and to cause them to urge the longitudinal edges of the two supporting fabrics together with a force sufficient to insure an effective seal. Any of the means heretofore described may be provided for sealing the two ends of the hood which extend transversely of the direction of movement of the felt and supporting fabrics. Of course any of the other means suggested herein for sealing the longitudinal edges of the hood in relation to the edge portions of the felt and supporting fabric may be used in lieu of the angle members 64 and 65. The advantage of employing the two fabrics 41 and 41a at opposite surfaces of the felt 27 is that it makes possible a suitable compression of the felt without subjecting the felt to wear-producing friction forces.

It will be understood that any of the schemes described above in relation to the Fig. 2 embodiment of the invention, for providing an effective seal along the edges of the opening through which air is blown through the fabric may be adapted for use in connection with the embodiment of the invention disclosed in Fig. 1. Also it should be understood that belts or bars used in effecting proper sealing may be of any appropriate cross-section, such as those described above whether used longitudinally or transversely of the direction of movement of the felt.

Figs. 11 and 12 disclose another form of apparatus which may be employed for the purging of water from felts. In this embodiment of the invention the felt 27 is delivered to and passed partially around a roller 66 and is then passed around a large, hollow, perforated drum 67. The perforations through the wall of this drum are indicated schematically at 67a in Fig. 11. It will be understood that these perforations are distributed completely around the circumference of the drum and in a direction longitudinally of the drum. After passing almost completely around the drum the felt is carried through a suitable arc around a small roller 68 from which it is delivered to a suitable point for reception of the paper web. An outer shell 69 almost completely surrounds the drum 67 and completely encloses the ends of the drum 67. In the circumferential direction around the drum 67, the portion of the roller 68 over which the felt is carried, is positioned at a point closely adjacent the corresponding portion of the roll 66. Close to the exit side of the nip between roller 66 and drum 67, the outer shell is provided with a sealing arrangement 69a, which may suitably be in the form of a channel member retaining a bar of wear resistant and low friction producing material, this bar extending throughout the length of the drum 67 which is engaged by the felt. Similarly, at the opposite side, the outer shell is provided with a sealing means 69b closely adjacent the roller 68. Air is introduced into the drum 67 through an inlet 67b under a suitable pressure and is blown outwardly through the openings 67a in the drum and through the felt to force water out of the interstices of the felt into the space between the shell and the outer casing 69. The water and moisture retaining air which thus collects within the casing is withdrawn from the latter through outlet 69c, that may suitably be connected to a vacuum or suction producing device. In the region between the rollers 66 and 68 there is provided a segment 70 mounted in good sealing relation to the drum 67, by any of the means heretofore described, adapted to prevent the discharge of any substantial amount of air into the atmosphere through the openings 67a in the drum, as the felt approaches and passes beyond the arc covered by the member 70.

To retain the felt 27 firmly against the outer surface of the drum 67 and to apply a certain compressive force to the felt, there is preferably employed a supporting fabric 41 which passes around the roller 66 beneath the felt 27 and then becomes disposed out-

wardly of the felt 27 in the passage of the latter around the drum 67. The means for rotating the drum 67 from a driving unit, such as 33 in Fig 2A, will serve to impart the desired movement to the felt 27 and the supporting fabric 41. Any suitable tensioning means may be applied to the supporting fabric to cause it to impart a squeezing action to the felt as the latter passes around the drum 67.

Fig. 12 shows an arrangement which may suitably be employed for sealing the edges of the felt and supporting fabric in the circumferential direction around the drum 67. This means may comprise a substantially annular channel member 71 carrying a substantially annular element 72 formed of suitable wear resistant and low friction producing material. Element 72 is shown as being rectangular in cross-section, but it may be of circular or trapezoidal or other cross-section. Sealing means of this characscribed above whether used longitudinally or the drum 67. The elements 71 and 72 may be secured to the outer casing 69 and should be co-extensive with the latter. If desired, they may be positioned outwardly of the end of the rollers 66 and 68 and the shield 70 as well as the longitudinally extending sealing members 69a and 69b. In this event they may extend at one end up to the plane which passes through the axes of the roller 66 and 67, and at their other ends to the plane which passes through the axes of the roller 68 and drum 67.

Turning now to Fig. 13, there is shown another embodiment of the invention which, like that shown in Figs. 11 and 12, provides for a substantial purging time even for a felt that is advancing at the rate required for a very high speed operation of the paper machine. In this embodiment, there is provided a large tank 73, which may be of rectangular cross-section both vertically and horizontally and which is adapted to receive air at a suitable rate and under a suitable pressure through an inlet 73a. The felt 27 to be purged is introduced into the tank through an opening 74 which is provided with sealing rollers or rods 75 to prevent the escape of any substantial amount of air through the opening 74. Felt 27 is then led successively around a number of perforated cylinders or drums 76 within the tank. After its passage around the successive drums or cylinders the felt is passed outwardly from the tank through an opening 77 provided with sealing rollers or rods 77a. As is shown in Fig. 14, each of the cylinders or drums 76 is provided with a large number of slots or perforations through its periphery throughout its length, and around its circumference. The air under pressure within the tank 73 will pass through the felt into the interior of the cylinders or drums 76. In those regions of the drums which are not surrounded by the felt, there is provided a shell 78 mounted in sealing relation to the periphery of each of the drums so as to prevent free movement of air into the drums without passing through the felt. The drums 76 are shown as being rotatably mounted on perforated hollow shafts 79, the perforations being indicated at 79b in Fig. 14. This arrangement is such that the moisture-laden air blown through the felt into the interior of the drums 76 will be passed into and through the interior of the hollow shafts 79 and discharged from the latter into any suitable collecting means disposed outside of the tank 73. If desired, the ends of all of the shafts 79 may be connected into a single chamber which may be maintained under a vacuum to assist in sucking the moisture-laden air out of the drums 76. Preferably the drums are arranged to rotate about their hollow shafts which remain stationary. However, the hollow shafts may be arranged to rotate with the drums, if desired. Also in lieu of providing each of the drums 76 with hollow perforated shafts, they may simply be provided with hollow trunnions at their two ends, these being journaled in suitable bearings.

In Fig. 15 there is shown a still further embodiment of the invention. In this embodiment there is provided a pair of squeeze or press rolls 80 and 81 through the nip of which the felt 27 is passed. Both rollers are perforated or of porous construction to permit the passage of air, water and the like. They may be formed as regular steel drums, with perforations throughout their circumference and a suitable portion of their length equal to the width of the felt, or they may be formed from ribbons of fiber metal to provide a honeycomb construction. In the drawing, the roll 80 is illustrated as being provided with perforations 80a and the roll 81 is shown as provided with perforations 81a. Within the roll 80 there is mounted an elongated receptacle 80b which is held stationary within the roll. It is provided with an air inlet 80c and an open arcuate outer face conforming with the inner surface of the roll 80. Suitable sealing means of the general character explained above, should be provided between the peripheral edges of the receptacle 80b and the inner surface of the roll 80. In a similar manner the roll 81 is provided with a receptacle 81b having an outlet 81c for the discharge of air and water collected by the receptacle. It is preferably provided with suitable sealing means around its periphery which engages the inner surface of the roll 81. The discharge of air and water from the receptacle 81b may be under atmospheric pressure, but it is preferably done under suction. The spacing of the rolls 80 and 81 may be made adjustable so that

as the felt passes through the nip the felt may be subjected to a desired amount of compression, preferably between 30% and 50% of the initial thickness of the felt. Air introduced under pressure into the receptacle 80b is forced through the openings 80a, through the felt 27 and then through the openings 81a into the receptacle 81b. This arrangement makes possible the subjection of the felt to gradually increasing compression up to a predetermined maximum while the air under pressure is forced through the same to purge the water therefrom. As the felt advances to the opposite side of the nip and outwardly beyond the same it is released of its compression and restored to its original thickness. During that portion of the arc in which the felt is subjected to increased compression it is possible to keep the compressed felt in a condition in which it has a film or layer of water which prevents the free passage of air through the felt. This enables the air to force the water out of the felt with a piston-like action. In that region in which the felt is free to expand again, beyond the point of maximum compression, it may no longer have an uninterrupted layer of water and the air may move through it more freely. This increases somewhat the volume of air needed, but it assists in further reducing the water content of the felt through entrainment and the like. If desired, the arc over which the receptacles 80b and 81b extend may be such as to encompass the region only in which the felt is subjected to increasing compression. In this event the forward or upstream walls of the receptacles 80b and 81b may be made adjustable so that these walls will be located in the region in which the rolls 80 and 81 just begin to compress the felt, of whatever thickness ii may be. This will serve to decrease the amount of air required to be introduced into the roll 80 under the required pressure.

A plurality of squeeze or press rolls 80 and 81 may be provided in series to act upon the felt successively, and thus increase the time during which air under pressure may be blown through the felt.

In the various forms of the invention described above, which involve the employment of a supporting fabric, it will be understood that the purging air will remove water not only from the felt but the supporting fabric as well. If it is found that the supporting fabric is not adequately purged of its water, but retains some which has been blown into it from the felt, separate air purging devices of any of the types described above may be positioned in the path of movement of the supporting fabric in the region where it is alone and not in contact with the felt.

It will be clear from the foregoing that the employment of the present invention makes possible the great reduction in the water content of the felt between the time it separates from the paper web until it is brought back into contact with the latter. This in turn makes possible the removal of a greater amount of water from the paper web than is possible by arrangements previously used or suggested. As a result of this the dryer portion of a paper machine may be reduced in size as compared with that found necessary at the present time. Also the invention makes possible the higher speed operation of the paper-making machine that has long been sought.

In connection with the various embodiments of the invention, as described above, with the exception of that shown in Fig. 15, it has been found highly desirable to have the openings or passages in the area in which the water purging air is blown through the felt of such cross-sectional area as to be more than 30% of the total area of the region in which the purging action takes place. This leads to more effective and more speedy removal of the water from the felt than if the cross-sectional area of the openings is less in proportion to the total area of the purging region.

It will be understood that various modifications of the invention, in addition to the various forms herein described in some detail, may be made within the scope of the invention.

WHAT WE CLAIM IS:—

1. A method of drying a paper machine felt in the course of operation of the machine during its travel between a point at which the felt leaves a pair of press rolls and is separated from a wet web and a point at which the felt is again brought into contact with another portion of the wet web, which comprises blowing air under a substantial superatmospheric pressure through successive portions of the felt to force the water therefrom for a sufficient period of time and at a sufficient pressure to reduce the water content thereof to between 10 and 40%, wet basis.

2. A method according to claim 1, wherein the air is blown through the felt under a pressure between 4 and 100 lbs. per sq. inch, and preferably between 4 and 20 lbs. per sq. inch.

3. A method according to claim 1 or 2, wherein the air is delivered under pressure to one surface of the felt in a manner to cause substantially all of the air to pass through the felt and to prevent any appreciable escape of the air laterally from the surface of the felt.

4. A method according to any one of claims 1 to 3, wherein the air is blown through a plurality of orifices against a surface of the felt, the felt being held firmly against the orifices as the air is blown there-

through.

5. A method according to claim 4, wherein the felt is held against the orifices by temporarily applying a porous carrier to the surface of the felt opposite the orifices, and advancing the felt and carrier across the orifices.

6. A method according to any one of the preceding claims, which includes introducing the felt between two porous carriers, and then advancing the carriers and the felt in unison as the air is blown therethrough.

7. A method according to any one of the preceding claims, wherein the successive portions of the felt are subjected to substantial compression as the air under pressure is blown therethrough.

8. A method according to claim 7, wherein the compression of the felt as the air under pressure is blown therethrough serves to reduce the thickness of the felt to the extent of between 30% and 50% of its normal thickness.

9. A method according to any one of the preceding claims, wherein the air blown through the felt is at a temperature which is not substantially above room temperature.

10. A method according to any one of claims 5 to 9, wherein the successive portions of the porous carrier are subjected to forces serving to remove liquid from the openings therein as the successive portions of the carrier pass through a region between the point at which they are moved away from the felt, after having been passed with the felt across the orifices through which air is blown jointly through the felt and the carrier, and the point where the successive portions of the carrier are again returned into contact with the felt.

11. A method according to claim 10, wherein said forces are created by high velocity air-jets directed through said successive portions of the carrier.

12. Apparatus for drying a paper machine felt in the course of operation of the machine during its travel between a point at which the felt leaves a pair of press rolls and is separated from a wet web and a point at which the felt is again brought into contact with another portion of the wet web, which comprises means having a discharge outlet for directing air under substantial superatmospheric pressure through said successive portions of the felt as it is advanced, the arrangement being such that the air is blown through said successive portions of the felt for a sufficient time and under sufficient pressure to force the water therefrom to such an extent as to reduce the water content of the felt to between 10 and 40%, wet basis.

13. Apparatus according to claim 12, which includes means for firmly retaining the successive portions of the felt against all portions of the periphery of said discharge outlet to provide an effective seal against the discharge of air along the surface of the felt.

14. Apparatus according to claim 13, wherein said means for retaining the felt comprises stationary, wear resistant and low friction creating elements extending longitudinally of the felt adjacent each edge thereof, and similar elements extending transversely of the felt completely across the forward and rearward ends of said discharge outlet.

15. Apparatus according to claim 14, wherein said wear resistant elements are disposed both above and below the felt.

16. Apparatus according to claim 13, wherein said means for retaining the felt comprises narrow belts positioned longitudinally of the felt to cooperate with the successive portions of the felt adjacent the edges thereof, means for advancing said belts at the speed of movement of the felt, and low friction creating and wear resistant elements extending completely across the forward and rearward ends of said discharge outlet and tranversely of the felt.

17. Apparatus according to claim 16, wherein said narrow belts are positioned both above and below the felt adjacent the edges thereof throughout the length of said discharge outlet.

18. Apparatus according to any one of claims 12 to 17, wherein at least one porous supporting belt is adapted to engage and cover one surface of the felt in the region in which the latter is advanced across said discharge outlet, whereby the air blown through said outlet is passed through both the felt and said supporting belt.

19. Apparatus according to claim 18, wherein means is provided for guiding said porous supporting belt along a path in which it is maintained in engagement with one surface of successive portions of the felt as the latter pass beyond said discharge outlet to the point at which said successive portions of the felt are separated from the paper web.

20. Apparatus according to claim 18 or 19, which includes means for directing said supporting belt away from the felt at a point beyond the region in which it is advanced with the felt across said discharge outlet and for directing said belt back into engagement with the felt at a point in advance of said region, and means for removing liquid from the openings of the porous supporting belt at a point between separation of the carrier from the felt and the point where contact between the two moving bands is restored.

21. Apparatus according to claim 20, wherein said last-recited means comprises means for directing high velocity jets of air through the porous supporting belt.

22. Apparatus according to any one of claims 13 to 18, wherein a pair of porous belts are adapted to engage and cover the

two surfaces of the felt in the region in which the latter is advanced across said discharge outlet, whereby the air blown through said outlet is passed through said felt and both of said porous belts to purge water from the same.

23. Apparatus according to claim 22, wherein said means for retaining the felt engages said porous belts laterally outwardly of said felt to squeeze said porous belts into sealing engagement, thereby preventing escapement of the air laterally of the surface of the felt.

24. Apparatus according to claim 18, wherein said porous supporting belt is adapted to apply a substantial compressive force to said felt.

25. Apparatus according to claim 24, wherein said porous supporting belt is adapted to apply a compressive force to said felt sufficient to reduce the thickness thereof to the extent of from 30 to 50% of the normal thickness thereof.

26. Apparatus according to claim 12, which includes a pair of press rolls between which said felt is passed, said press rolls serving to compress said felt to a substantial extent as the felt passes through the nip thereof, said rolls being provided with perforations, one of said rolls having a receptacle therein arranged to receive air under superatmospheric pressure and the other of said rolls having a receptacle therein arranged to receive and discharge air and water from said felt.

27. Apparatus according to claim 26, wherein said rolls are adapted to compress said felt to the extent of 30 to 50% of its normal thickness in its passage between said rolls.

28. Apparatus according to any one of claims 12 to 25, wherein said means for directing air under superatmospheric pressure through said felt has a dimension lengthwise of the movement of the felt sufficient to enable blowing of the air through the felt for a period of time sufficient when the felt is running at the normal speed of operation to reduce the moisture content of the felt to between 10 and 40%, wet basis.

29. Apparatus according to claim 12, which includes a hood connected with said means for directing air through said felt, and a receptacle aligned with said hood for receiving said air and water delivered from said felt.

30. Apparatus according to claim 12, which includes a perforated drum adapted to be rotated at a peripheral speed equal to the speed of advance of the felt, means for delivering the felt to said drum and removing the same from said drum in such a manner as to cause said felt to travel with said drum over a substantial portion of the circumference of the latter, means for introducing air under pressure into the interior of said drum for discharge through the perforations therein and through said felt, and means surrounding a substantial portion of said drum for collecting the air and water discharged from said felt.

31. Apparatus according to claim 12, which includes an enclosed chamber into which air is delivered from said discharge outlet, a plurality of perforated rollers journaled in said chamber, an inlet into said chamber through which said felt may be introduced and passed successively around said perforated rollers, an outlet from said chamber through which said felt is discharged therefrom, and means connected with the interior of said rollers for collecting the air and water discharged through and from said felt by the air under pressure within said chamber.

32. Apparatus according to claim 31, which includes means for substantially preventing the passage of air from within said chamber to a point outwardly thereof without passing through said felt into the interior of said rollers.

33. Apparatus according to any one of claims 12 to 32, wherein said means for directing air through successive portions of the felt has air delivering passages therethrough which have a total cross-sectional area which is at least 30% of the total area of the felt in the region in which air is being blown therethrough.

34. A method of drying a paper machine felt in the course of operation of the machine during its travel between a point at which the felt leaves a pair of press rolls and is separated from a wet web and a point at which the felt is again brought into contact with another portion of the wet web, substantially as hereinbefore described with reference to the accompanying drawings.

35. Apparatus for drying a paper machine felt in the course of operation of the machine during its travel between a point at which the felt leaves a pair of press rolls and is separated from a wet web and a point at which the felt is again brought into contact with another portion of the wet web, substantially as hereinbefore described with reference to the accompanying drawings.

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Agents for the Applicant.

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1008668 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG.1.

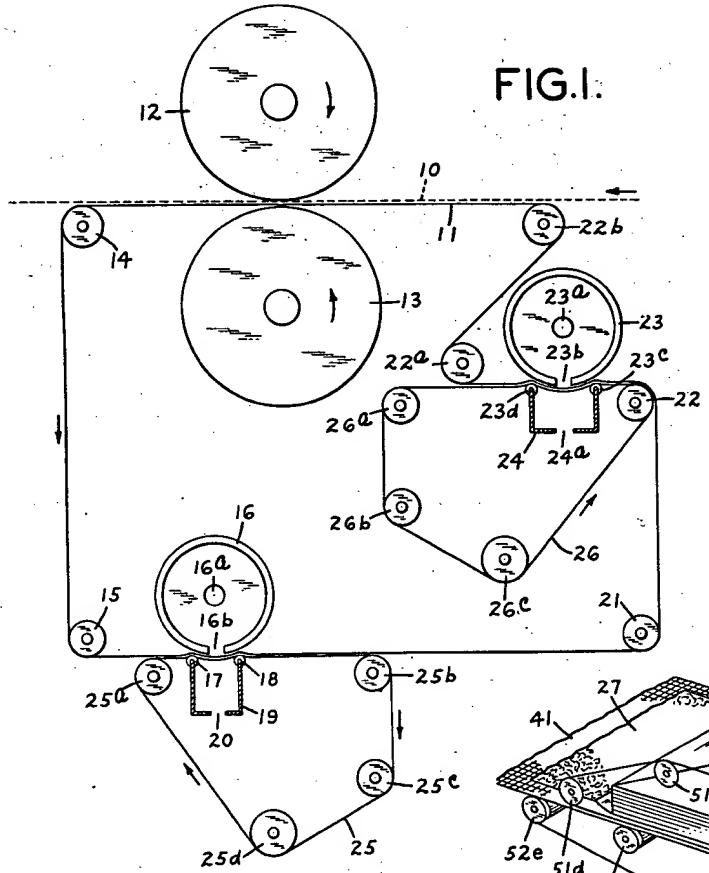


FIG.3.

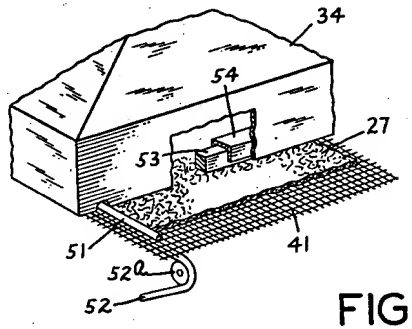
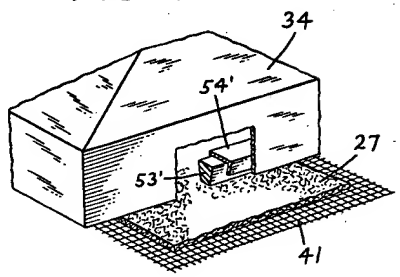


FIG.4.



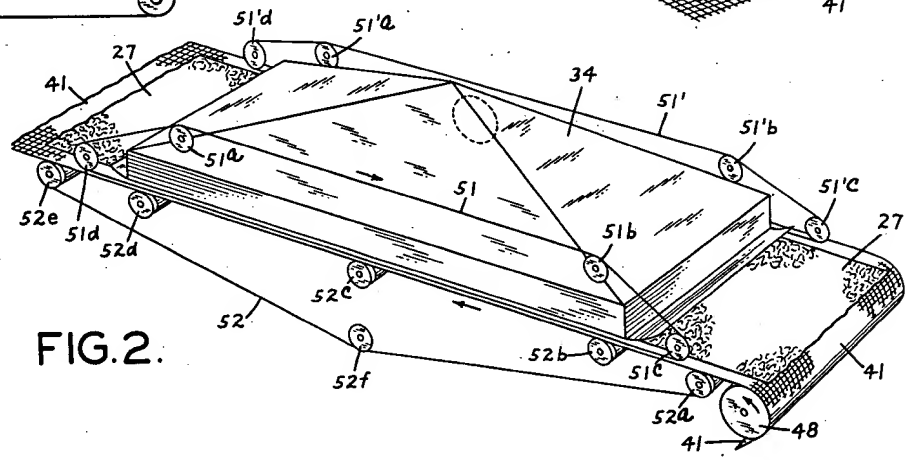


FIG.2.

1008668 COMPLETE SPECIFICATION
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Sheet 2

FIG.2A.

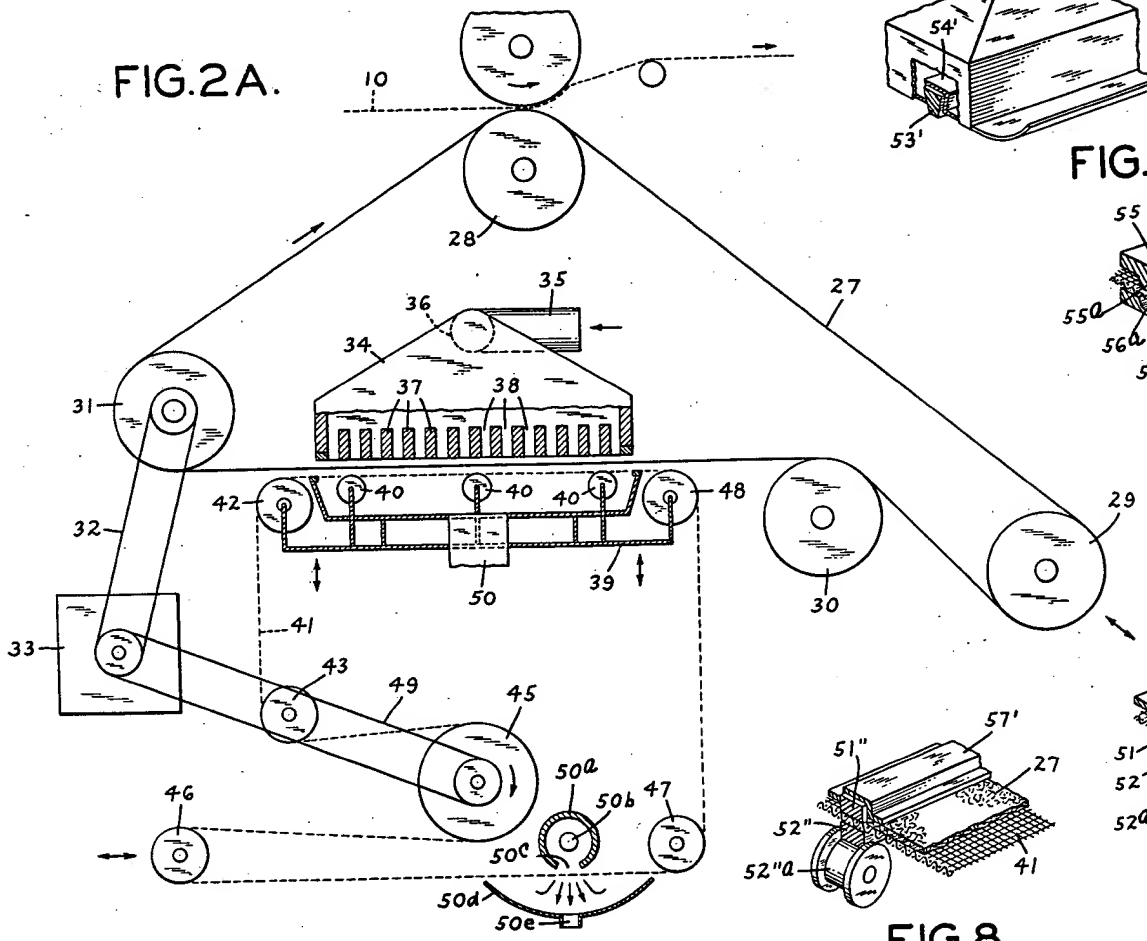


FIG.5.

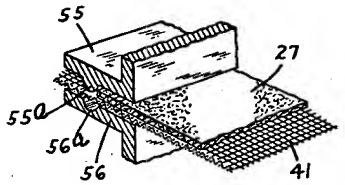


FIG.6.

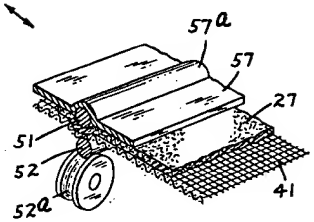
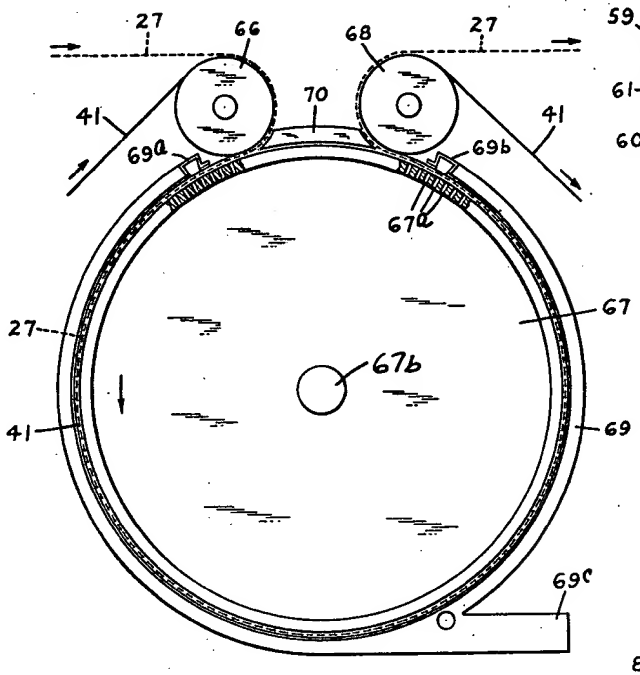


FIG.7.

FIG.8.

1008668 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 3

FIG.11.



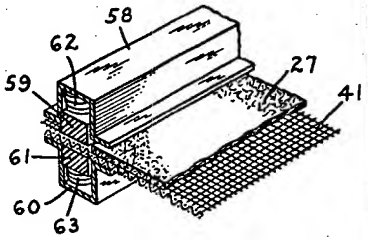


FIG.9.

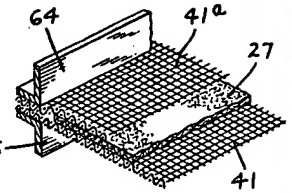


FIG.10.

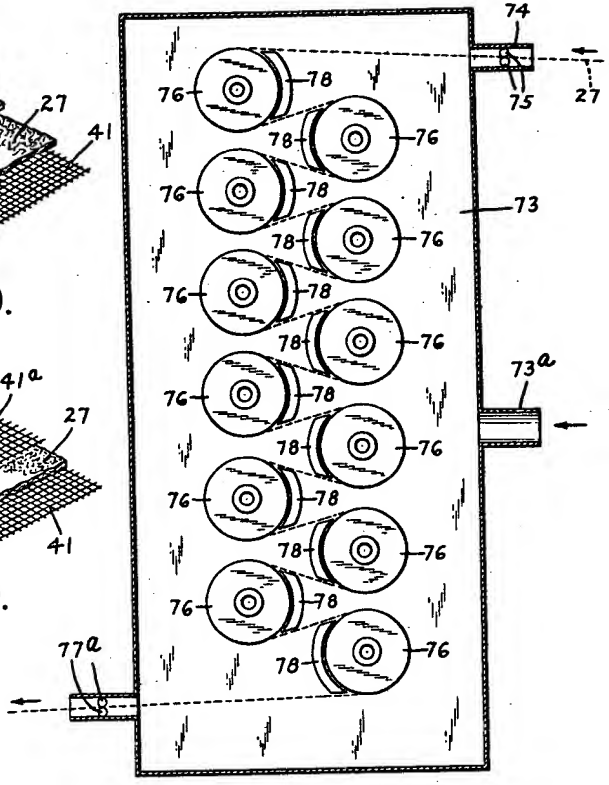


FIG.13.

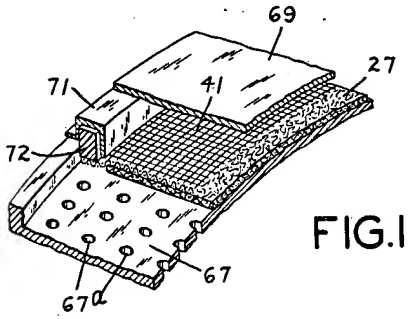


FIG.12.

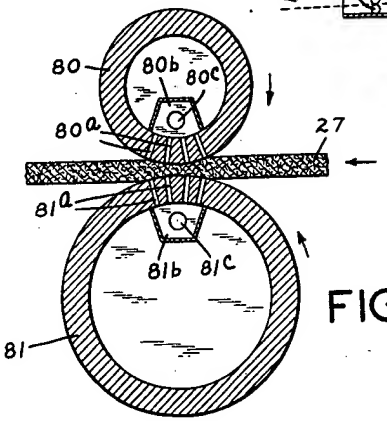


FIG.15.

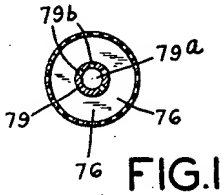


FIG.14.